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RESULTS OF A 1977 PILOT PROJECT TO EVALUATE THE EFFECTIVENESS OF SEVIN INSECTICIDE IN PREVENTING ATTACKS BY THE MOUNTAIN PINE BEETLE IN LODGEPOLE PINE ON THE TARGHEE NATIONAL FOREST, IDAHO

by

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FOREST INSECT AND DISEASE MANAGEMENT
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RESULTS OF A 1977 PILOT PROJECT TO EVALUATE THE EFFECTIVENESS OF SEVIN INSECTICIDE IN PREVENTING ATTACKS BY THE MOUNTAIN PINE BEETLE IN LODGEPOLE PINE ON THE TARGHEE NATIONAL FOREST, IDAHO

ABSTRACT

A pilot project was undertaken to evaluate the effectiveness of Sevin® insecticide in preventing attacks by the mountain pine beetle in lodgepole pine. The insecticide was applied as a 2 percent water-based spray. As a comparable standard, 1.3 percent Lindane was applied to alternate blocks of trees. Methods used in tree selection, plot design, and chemical application are described. Results indicate preventive treatments at the percentages used are 100 percent successful using Sevin and 45 percent successful using Lindane.

INTRODUCTION

Though populations of the mountain pine beetle, Dendroctonus ponderosae Hopkins, are on the decline throughout most of the Intermountain Region, areas on several Forests are still experiencing widespread tree killing. Direct control measures have met with little or no success in the past and have largely been abandoned as a management technique. Emphasis is now being placed on the prediction of stand susceptibility using the criteria of elevation-latitude, average age, and average dbh (Amman, McGregor, Cahill, and Klein, 1977). Through the utilization of these stand characteristics, land managers may rate individual lodgepole stands for potential risk of beetle infestations. By reducing either stand age or average diameter, susceptibility to beetle attacks can be markedly reduced.

These management techniques will undoubtedly find widespread use where the mountain pine beetle threatens lodgepole forests. As the only feasible method of reducing losses on a large scale, stand management holds promise for keeping beetle populations in check. Yearly losses will continue to exist in wild stands, and these endemic losses must be accepted as inevitable.

There are areas, however, where even endemic losses may be unacceptable. In campgrounds, residential areas, or other places where individual trees have high aesthetic or other values, we may wish to protect these trees from year to year. Preventive sprays have been tested throughout the West for several years--some having a certain amount of success (Smith, Trostle and McCambridge, 1977). In 1975, Region 4 personnel conducted a preventive spray pilot test using Dursban®, Lindane, and Sevin® as diesel oil-formulated sprays on the Targhee

National Forest, Idaho. Though disappointing, the results served as the basis for a pilot study using these same chemicals as water-based applications in 1976 (Klein, 1976). The results of that study, also conducted on the Targhee National Forest, were most encouraging and were responsible for the pilot project carried out in 1977 (Gibson, 1977).

The purpose of this project was to evaluate the efficacy of Sevin (carbaryl) insecticide as a 2 percent water-based preventive spray under operational conditions. Lindane was applied at its registered rate of 1.3 percent to alternate blocks of trees as a comparative standard. The following is a report of this pilot project.

TEST SITE

The site of the pilot project was along Black Canyon Loop Road near Reas Pass on the Island Park Ranger District, Targhee National Forest. This is an area several miles east of the 1976 pilot study site and about eight miles north of the campground in which the 1975 spraying was conducted (Figure 1). The site was selected using several criteria: the area would have to be easily accessible for trucks, there must be enough lodgepole pines attacked in 1976 to provide 1977 attacks, and yet enough green trees to accommodate the project requirements, and finally the area would have to be acceptable to the Island Park District Ranger. Using aerial survey sketch maps and trend data from the 1976 study site, the Reas Pass area was selected. Subsequent ground checking and consultation with District personnel indicated the proposed site met all the selection criteria (Figure 2).

Individual treatment tree selection was based on the following: (1) each treatment tree must be at least 9.5 inches dbh, (2) each treatment tree must have at least 2 unattacked trees to serve as checks, also at least 9.5 inches dbh, within a radius of 33 feet, (3) treatment trees must be at least 33 feet apart, and (4) treatment trees must be within 200 feet of an access road. Potential treatment trees were thus selected and each tree became, in a sense, a treatment "plot" (Figure 3). To accommodate a statistical design, treatment trees were selected in groups of 25--each 25 "plots" becoming a sub-block. Two sub-blocks comprised a spray block. Six such spray blocks were selected and marked in mid-April. This gave us a total of 300 treatment trees, 150 for each insecticide. We had hoped to do 10 spray blocks (500 trees), but only a few more trees meeting our criteria could be found in the vicinity. No other suitable sites could be found on the District.

In early May, the 300 treatment trees were numbered with aluminum tags and a flourescent orange "X" was painted on the base of each tree. Each associated check was marked with a "dot" which faced the tree for which it was serving as a check. As noted in Figure 3,

some checks served more than one treatment tree. Table 1 lists average tree sizes for both treatments and checks, average number of checks for each treatment tree, and attack ratios for check trees by spray block.

METHODS AND MATERIALS

Statistical Design

One objective of this pilot project was to compare the percentage of trees successfully protected against beetle attack by Sevin with that percentage protected by Lindane. To accommodate this comparison we intended to analyze the variance of each insecticide using an arcsin transformation in a standard two-way classification for randomized blocks. For these purposes, treatment trees were marked in sub-blocks of 25 trees, with 2 sub-blocks to a spray block. Sub-blocks were separated by an untreated strip 2 chains wide, and spray blocks were separated by a strip 5 chains wide. Within each spray block, one sub-block would receive Sevin spray, the other would receive Lindane. The chemical applied to the first of any two particular sub-blocks was chosen randomly at the time of application. The other insecticide was then applied to the second sub-block.

Chemical Formulation

Chemicals were mixed daily at the Island Park Ranger Station where the insecticides were kept in a locked, identified, and isolated storage building. Prior to mixing, we metered the pH of the water that was used. This was done because of the propensity of some insecticides, principally Sevin, to decompose rapidly in alkaline mixtures. The pH of the water at the Ranger Station measured 7.4, which we deemed too high for our purposes. Through trial and error, we found one quart of commercial acetic acid (vinegar) lowered a tank of water to an acceptable pH of 5.9. Thereafter, one quart of vinegar was added to each tankful of insecticide mix.

To obtain the proper percentage of each insecticide, i.e. 2 percent Sevin and 1.3 percent Lindane, we mixed each in accordance with its respective label directions. Sevimol 4, a 40 percent suspension of Sevin insecticide in a molasses carrier was mixed in the proportion of 1 gallon Sevimol 4 to 23 gallons of water. Isotox Lindane Spray No. 200, a 20 percent emulsifiable concentrate, was mixed at a ratio of 1 gallon Lindane to 15 gallons water. For our purposes we mixed one spray tank with 4 gallons of Lindane, 60 gallons of water, and one quart of vinegar. The other was mixed with 3 gallons Sevimol 4, 69 gallons water, and one quart of vinegar. This provided each tank with enough mixture to treat approximately 30 trees.

Tanks were emptied daily, with any mixture not used being dumped at the Island Park Sanitary Landfill. The tanks were cleaned periodically by flushing with one pound of neutralizing agent in 50 gallons of water. This, too, was dumped at the landfill. All residues or cleaning mixtures disposed of in the landfill were buried.

Application Equipment

To apply the chemicals, we used two 4-cycle, gasoline-powered, piston-pumps. The pumps were portable and mounted on the beds of pickup trucks. Each pump was attached to a 100-gallon tank and was equipped with a mechanical agitator and recirculation system. Each truck also had a hand operated hose reel with 200 feet of rubber hose mounted to its bed (Figure 4).

Spraying was done with a #4006 Tee-Jet nozzle in a standard spray head attached to a 30-foot telescoping fiberglass pole. Thirty feet of clear rubber tubing was attached to the spray head and a toggle-action valve was affixed to the base section of the pole (Figure 5).

Spray Application

Two 2-man crews applied the insecticides. While one crew was applying Sevin in one sub-block, the other crew was spraying Lindane in its associated sub-block. We began spraying on June 14 with Lindane being applied to trees 1-25, Sevin to trees 26-50. Spraying was completed on June 19.

Each pump was equipped with a gauge and pressure regulator. To reduce splash and drift, mixtures were applied at approximately 40 psi. At this pressure, and by applying the mixtures to a point of runoff, we used about one gallon of spray mixture for each 50 square feet of bark surface. This averaged 2 gallons of spray per tree.

Spray application was accomplished by extending the pole to its full height and releasing the spray as the pole was lowered section-by-section (Figure 6). For most trees, the pole would have to be raised and lowered three times, the whole procedure taking between 5 and 10 minutes per tree. In this manner a two-man crew could spray 25 to 30 trees each day.

Safety Equipment

Though the dermal toxicity of both Lindane and Sevin is quite low, certain precautions were necessary. Each man wore coveralls, a hard hat with face shield, a respirator, rubber gloves and rubber boots while applying the chemicals (Figure 4). Coveralls, gloves, and boots were worn while mixing or otherwise handling the insecticides. Each truck was supplied with clean water, paper towels and

soap to clean hands, face, or equipment as needed. Coveralls were changed daily and worn only once before being laundered.

Insecticides

Lindane is a chlorinated hydrocarbon widely used in a number of forestry and agricultural applications. It has been registered for use against the balsam woolly aphid, some wood borers, and some bark beetles, to list a few. Though slightly more toxic to mammals and birds than carbaryl, its toxicity to these animals is regarded as low. When applied at registered levels, it has exhibited no adverse affects on wildlife; nor has it shown any phytotoxic properties (Chevron Chemical Company, 1965). Though slightly persistent in soils, the method of application used in this pilot project minimized the possibility of environmental damage.

Sevin (carbaryl), a carbamate, has found wide usage against both agricultural and forest pests. It is registered for use against such forest insects as the gypsy moth, tent caterpillars, elm leaf beetle, and spruce budworm. Carbaryl exhibits good residual properties, and has shown only minor phytotoxic reactions in the form of leaf drop on some fruit trees. At normal dosage rates, it has a very low toxicity to vertebrates. It is, however, quite toxic to non-target insects--especially honeybees (Union Carbide Corp., 1976).

TREATMENT EVALUATION

In order to determine past beetle mortality, as well as future pressure in the area, 40 ½-acre trend plots were established in the lodgepole stand surrounding the project site (Figure 2). These were laid out where practical, at right angles to the road. Fixed plots were started one chain from the road and were ½-chain wide and 10-chains long. From these fixed plots all past beetle-killed trees were recorded by diameter. At the end of each fixed plot, a variable plot (BAF 10) was established from which green stand data were recorded. Following beetle flight, the fixed plots were cruised again to record 1977 attacks. Tables 2 and 3 list these data.

Evaluations for treatment effectiveness were conducted in late September following the beetle flight period. Within each sub-block, these evaluations were based on those treated trees considered to have been subjected to beetle attack. A treated tree was considered to have been under attack by the beetle only if: (1) the treated tree was attacked, regardless of the condition of its checks, or (2) the treated tree was not attacked but at least one of the checks in the treatment "plot" was attacked. If neither of these criteria were met, that entire plot was disregarded. Only those treated trees subjected to attack contributed to the percent successfully protected. This is the variable within each sub-block which was ultimately evaluated.

We considered a tree successfully attacked, if in our judgement, it contained sufficient attacks and/or brood to cause mortality. During the evaluation, each treated tree was evaluated and placed in one of the following categories: (1) not attacked, (2) attacked, (3) strip-attacked, (4) pitchouts, (5) attacked above spray height, or (6) disregard. Attacks above 30 feet were verified with binoculars.

An additional aid, used to measure treatment effectiveness, was the placement of catchment traps around the base of selected trees (Figure 7). These traps were made of muslin and held in place by wires at the base and nylon hoops attached to wooden supports at the top. Three traps were randomly placed in each spray block--one on a Sevin treated tree, one on a Lindane tree, and one on a check. The traps were constructed to catch any insect which fell from the bole of the tree after it had been killed by the insecticide. The traps served two important purposes. First, we wanted to ascertain that the beetles were, in fact, being killed and not just repelled by the treatments. Second, we needed to know if significant numbers of non-target insects were being killed.

RESULTS AND DISCUSSION

Following the outstanding results with Sevimol 4 in the 1976 study, we anticipated similar success in 1977. That proved to be the case with a 100 percent success ratio obtained. Tables 4 and 5 show success per spray block. A compilation of this data indicates that of the 150 trees treated with Sevimol 4, 82 were not attacked, none were successfully attacked, 5 had one or two pitchouts, and 22 were attacked above spray height. Forty-one "plots" had no beetle pressure and had to be disregarded. In computing percent success, pitchouts and those attacked above spray height were considered not attacked. Percent success, then, is 100 percent--of 109 valid comparisons, 109 were successfully protected.

We had anticipated higher success with Lindane than that obtained. Last year the success ratio for Lindane was 74 percent. However, the application percentage of the insecticide was lowered from 2 percent last year to 1.3 percent this year. Results were somewhat disappointing. One hundred fifty trees were treated; 38 were not attacked, 47 were attacked, 4 had strip-attacks, 4 had pitchouts, none were hit only above spray height, and 57 had to be disregarded. Applying the above criteria, of 93 valid comparisons, only 42 were protected--a success ratio of 45 percent.

The statistical design we had intended to use in the data analysis thus became ineffective by the lack of variance in the Sevin blocks. Jensen (1977) stated:

> The result of this pilot project is unique in that, of the two treatments tested in a six-block design, Sevin

gave complete protection in every block (average = 100 percent), Lindane giving only fractional protection in each block (average = 45 percent). The intended randomized block analysis of protection percentage under arcsin transformation is rendered invalid by the zero-variance response to Sevin. But, at the same time, the treatment contrast is so strong as to provide an excellent basis for intuitive evaluation, wherein treatment difference must certainly be regarded as being beyond sampling chance.

The catchment traps were not utilized as fully as we had hoped; however, they did provide some valuable information. Due to personnel limitations, only 3 collections were made from the traps. One was prior to beetle flight, the other two after the flight period was over. Though the small number of collections rendered the data far from conclusive, we do know that mountain pine beetles were killed in high numbers on trees treated with both insecticides. Few insects at all, and no dead mountain pine beetles, were found in traps on the check trees. Also, no other insects were found in significantly high numbers in the traps on treated trees. A number of Tachinid flies were found, but in sufficiently small numbers to be rather meaningless.

Total project costs are enumerated in Table 6. Considering only equipment and material costs, the treatment per tree totals $9.33. Though this figure seems high, a large portion of those costs are one-time expenditures which could be discounted over several years if used operationally. Only the cost of insecticides, pump rentals, and some supplies would be incurred every year. Discounting total fixed costs over a 5-year period and adding yearly costs to spray 300 trees, for example, reduces the amount per tree to $3.10. This figure does not include salaries or truck expenses. (As a comparison, a commercial firm spraying trees on private land in the Island Park area last summer charged $3.50 to $4.50 per tree, depending upon tree size and proximity to other trees). We have data which suggest trees may be protected for as long as two years with one spray application. However, until more conclusive data are obtained, yearly applications may be necessary throughout the 3 to 5 years an infestation takes to move through a given area.

CHEMICAL ANALYSIS

Arrangements were made with Dr. Eugene Brady, University of Georgia, Athens, Georgia, for his laboratory to serve as "quality control" agent for the project. As insecticides were mixed each day, a batch sample was taken and frozen immediately to be sent to Dr. Brady. On the final day of spraying, a 4-inch by 4-inch bark sample was taken from each of 15 trees (5 from each insecticide group and 5 checks)

sprayed that day. These would serve as zero-day samples from which pesticide content in ppm would be analyzed. One hundred and ten days after application, 15 additional samples were taken from the same trees to measure pesticide residues. These analyses are not yet completed. The data derived from these analyses will provide the basis for a later report.

SUMMARY

The results of this pilot project provide substantial evidence as to the efficacy of Sevin insecticide as a preventive spray against the mountain pine beetle in lodgepole pine. Results from 1976 coupled with those from this year indicate this technique can be used successfully on an operational basis. Per tree costs would obviously prohibit large-scale spray projects. But, in areas of high aesthetic values, preventive treatments such as this, coupled with proper management techniques, will successfully protect trees with high potential for beetle attacks.

Operationally, some application modifications may be desired. Though the method used in this project ideally suited our needs, other methods could be developed which would possibly be more suited to operational conditions. One such modification might be the use of high pressure pumps and nozzles which could be applied from the ground and yet spray high enough to be effective. Under these conditions the operator need not be overly concerned with spray drift on adjacent trees. Too, spraying in this manner, especially in clumps of trees, would greatly reduce the time required to spray each tree.

Results from the 1976 test enabled Union Carbide Corporation to obtain an EPA label for the use of Sevimol 4 as a preventive spray in the State of Idaho. It is hoped that an additional year's data will lead to a West-wide label for its usage. We now believe that land managers and private citizens have a safe, efficient, and economical means of protecting high-value lodgepole pines from attack by the mountain pine beetle.

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APPENDIX

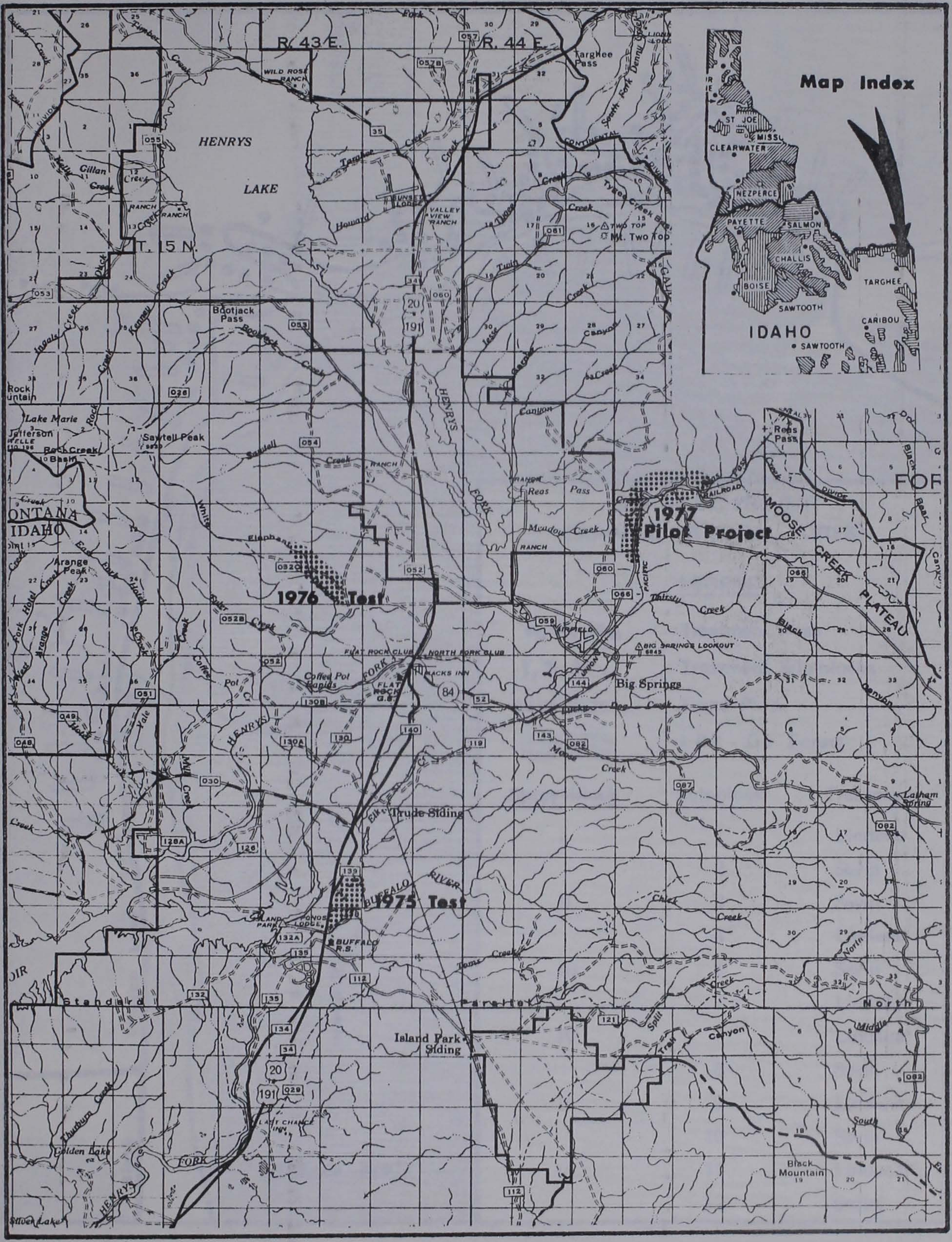


Figure 1. Pilot Project Location Map, Targhee National Forest

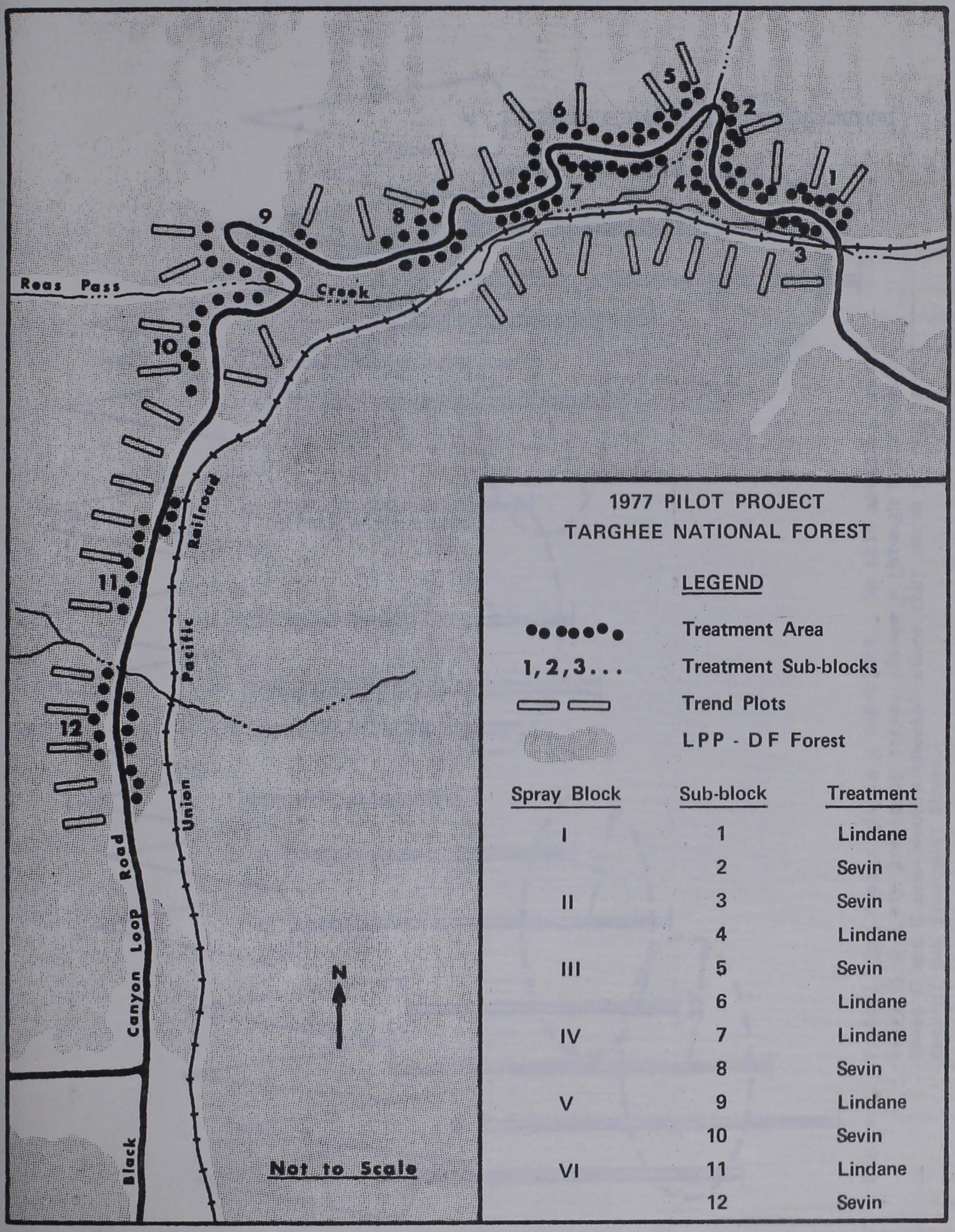


Figure 2. Pilot Project Site Map

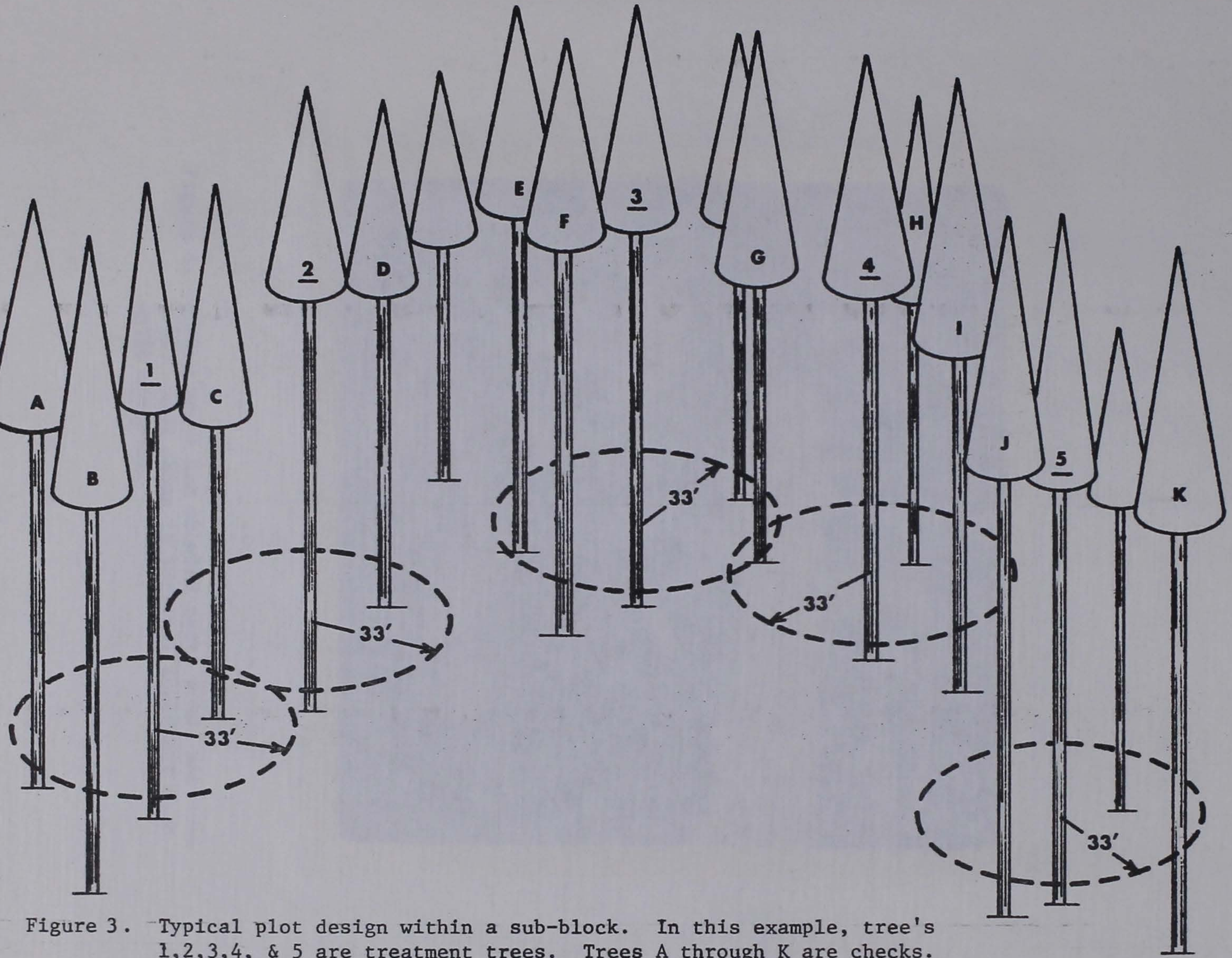


Figure 3. Typical plot design within a sub-block. In this example, tree's 1,2,3,4, & 5 are treatment trees. Trees A through K are checks. Trees C and G are "double checks" since they serve as checks for each of two treatment trees.



Figure 4. Pickup truck bed showing tank, pump, and hose reel. Also shown is personal equipment used while spraying.



Figure 5. Telescoping pole, nozzle, valve and hose used to apply insecticides.



Figure 6. Spraying of insecticide showing application technique.



Figure 7. Placement of catchment traps which were used to monitor effects of insecticides on the mountain pine beetle and non-target insects.

Table 1. Treatment tree and check tree comparisons.

Spray Block	Insecticide	Number Treated	Number Attacked	Average d.b.h.	Number Checks	Number Attacked	Average d.b.h.
I	Lindane	25	3	11.0	108	70	10.6
	Sevin	25	0	10.8	124	87	10.6
II	Lindane	25	16	11.2	85	49	10.5
	Sevin	25	0	11.6	125	87	11.1
III	Lindane	25	10	11.1	82	48	11.2
	Sevin	25	0	11.2	97	44	10.8
IV	Lindane	25	8	10.7	66	30	10.6
	Sevin	25	0	10,2	62	22	10.1
V	Lindane	25	12	11.8	74	36	10.7
	Sevin	25	0	12.1	68	51	11.1
VI	Lindane	25	2 1/	10.6	71	4 1/	10.1
	Sevin	25	0	10.3	67	19 2/	10.5
Total	Lindane	150	51	11.1	405	237	10.6
	Sevin	150	0	11.0	543	310	10.7

1/ Nine "plots" logged prior to evaluation.

2/ Seven "plots" logged prior to evaluation.

Table 2. Green stand data--based on 40 variable plots (BAF10).

Diameter Class	TREES PER ACRE Lodgepole Pine	Douglas Fir	Total
6	85.31	-	85.31
7	61.74	-	61.74
8	40.11	1.43	41.54
9	23.20	0.57	23.77
10	14.21	0.46	14.67
11	9.47	-	9.47
12	3.50	0.64	4.14
13	2.98	-	2.98
14	0.93	-	0.93
15	0.41	-	0.41
25	-	0.07	0.07
28	-	0.06	0.06
32	-	0.04	0.04
Total	241.86	3.27	245.13
Percent	98.67	1.33	100.00

Table 3. Trend plot data--based on 40, ½-acre plots.

Diameter Class	TREES PER ACRE					
	1977 Hits	1977 Strips	1976 Hits	1975 Hits	Snags	Total Dead
6	0.67	0.22	0.05	0.00	0.20	1.14
7	1.94	0.83	2.25	0.30	0.25	3.57
8	3.72	1.33	1.00	0.05	0.90	7.00
9	5.11	0.89	2.10	0.40	1.55	10.05
10	3.89	0.89	1.75	0.65	2.05	9.23
11	2.50	0.33	2.15	0.25	1.95	7.18
12	1.67	0.44	1.20	0.25	1.80	5.36
13	0.56	0.11	1.00	0.20	1.65	3.52
14	0.56	0.06	1.05	0.15	1.45	3.27
15	0.00	0.00	0.35	0.05	0.65	1.05
16	0.00	0.00	0.10	0.10	0.50	0.70
17	0.56	0.00	0.10	0.05	0.05	0.76
18	0.11	0.00	0.05	0.10	0.10	0.36
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.50	0.50
Total	21.29	5.10	11.15	2.55	13.60	48.59
Percent	43.82	-	22.95	5.25	27.98	100.00

Table 4. Post spray evaluation summary.

Spray Block	Insecticide	Not Attacked	Attacked	Strip Attacked	Pitch-outs	Attacked Only Above 30'	No Checks Attacked
I	Lindane	17	3	0	2	0	3
	Sevin	22	0	0	0	0	3
II	Lindane	3	15	1	0	0	6
	Sevin	14	0	0	1	8	2
III	Lindane	4	9	1	1	0	10
	Sevin	14	0	0	0	2	9
IV	Lindane	9	7	1	1	0	7
	Sevin	13	0	0	2	2	8
V	Lindane	3	11	1	0	0	10
	Sevin	12	0	0	1	8	4
VI	Lindane	2	2	0	0	0	12 1/
	Sevin	7	0	0	1	2	8 2/
Total	Lindane	38	47	4	4	0	48 1/
	Sevin	82	0	0	5	22	34 2/

1/ Nine "plots" logged prior to evaluation.

2/ Seven "plots" logged prior to evaluation.

Table 5. Success ratios.

Spray Block	Insecticide	Not Attacked 1/	Attacked 2/	Valid Comparisons	% Success
I	Lindane	19	3	22	86
	Sevin	22	0	22	100
II	Lindane	3	16	19	16
	Sevin	23	0	23	100
III	Lindane	5	10	15	33
	Sevin	16	0	16	100
IV	Lindane	10	8	18	56
	Sevin	17	0	17	100
V	Lindane	3	12	15	20
	Sevin	21	0	21	100
VI	Lindane	2	2	4 3/	50
	Sevin	10	0	10 4/	100
Total	Lindane	42	51	93	45
	Sevin	109	0	109	100

1/ Not Attacked = Not Attacked + Pitchouts + Attacked Only Above 30'.

2/ Attacked = Attacked + Strip Attacked.

3/ Nine "plots" logged prior to evaluation.

4/ Seven "plots" logged prior to evaluation.

Table 6. 1977 pilot project costs.

Item	Contributed		Project Funds	
Chemicals				
Sevimol-4	30 gallons	$340.50	5 gallons	$ 56.75
Lindane			50 gallons	722.50
Nutra-Sol			12, 1 lb cans	24.00
		$340.50		$803.25
Equipment				
Aluminun tags - 1000				44.45
Assorted tools, hard hats - 4, flagging - 20 rolls				114.78
Face Shields - 4				32.60
Tree marking paint - 24 cans				62.88
Wood Stakes - 6 bundles				27.60
Vials - 1 gross				26.25
Rubber gloves - 4 pair				13.23
Respirators - 1 case				106.45
Equipment carriers - 5				100.00
Miscellaneous equipment (buckets, bolts, etc.)				26.39
Coveralls - 12 pair		116.94		
Telescoping pole - 2		208.00		
Nozzles & Valves - 2 each		16.00		
Flexible tubing - 100 feet		10.50		
		$351.44		$554.63
Services				
Pump Rental - 2				750.00
Lab analysis - bark residues (plus mailing)				374.20
Truck Rental and Mileage		2358.00		
		$2358.00		$1124.20
Travel and Per Diem		$2818.00		
Salaries		$7310.00		
Totals		$13,177.94		$2482.08
Project Total				$15,660.02